Vibration Test Equipment

MP MASTER
MA23489

DERRITRON ELECTRONICS LIMITED

User's Handbook for

TRUE R.M.S. VOLTMETER TYPE TRV1

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SECTION 1

Introduction

1.1. General Introduction

The True RMS Voltmeter is basically intended for use in equalizing and analysing equipment in vibration systems, but, due to its comprehensive specification, the instrument may be used for any application which requires a sensitive LF voltmeter. An all solid-state circuit is used, the majority of the devices being silicon. Provision of a suitable selection of time constants enables the instrument to be used for measurements on random noise signals as well as for the measurement of sinusoidal signals.

1.2. Special Features

The input circuits are protected against the effects of overvoltage up to a peak level of 500 volts, and their high input impedance prevents excessive loading of the circuits under test. Special precautions are taken in the metering circuits to ensure that errors caused by changes in ambient temperature are minimised. An output is available from the meter amplifier circuits for use in other equipment, so that the instrument can also be used as an accurately calibrated amplifier if so required. This output is protected against short-circuits. Stabilised power supplies are used for all the internal circuitry, and the instrument may be supplied for operation from other supplies than the standard 200/250V 50Hz mains if so required.

SECTION 2

Technical Specification

2.1. General Specification

Ranges:	Full scale deflection for: 1, 3.16, 10, 31.6, 100, and 316mV 1, 3.16, 10, 31.6, 100, and 316V
Range accuracy:	Better than 2% total, measured at 1KHz.
Input Impedance:	Greater than 1 megohm on all ranges and protected against overvoltage up to 500V.
Frequency Response:	On 100mV range - $\pm$0.2dB from 3Hz to 200Khz and -0.5dB @ 2Hz & 250KHz On other ranges - $\pm$0.2dB additonal to that of 100mV range.
Temperature Stability:	Better than 2% of f.s.d. from $0^{o}C$ to $40^{o}C$.
Noise:	Less than 10 microvolts with short circuit input on 1mV range.
Meter Scaling:	5" anti-parallax scale with ranges calibrated 0-10 and 0-3.16V, 0-20dB, (and $0\text{-}10g^{2}/Hz$, but this is not used on this version of the instrument).
Meter Accuracy:	2% of full scale deflection. (BS89/1954)
Rectifier Circuit:	Quasi-rms detector giving true rms detection of Gaussian random noise up to 3 sigma, and also of sinusoidal signals.
Time Constants:	0.3, 1, 3, 10, 30, and 100 seconds averaging time.

Monitor Output:	4.5V rms signal for meter fsd. The output is protected by a resistance of 70 ohms and is short-circuit proof.
Power requirements:	100-125V or 200-250V AC 50/60Hz @ 12VA.
Construction:	Totally enclosed 19x7x17" rack mounting.
Circuitry:	All solid state.

SECTION 3

General Description

3.1. Introduction

The instrument is most conveniently descibed by reference to its block schematic diagram. Physically the circuit divides into two sections, a range multiplier unit and an RMS meter drive unit, each containing four subsections.

3.2. Range Multiplier Unit

The input signal is applied to the first two sections of the range selector switch, which introduce additional attenuation on the four highest ranges. From here it is fed to a high input impedance, unity gain preamplifier, which incorporates overload protection circuits, and then to the third section of the range selector switch. This operates in conjunction with a pair of amplifiers, each of which has a gain of ten. The range switching and amplifiers together provide a decade selection system, and it only remains to provide a selection of '1' or '3.16' to operate in conjunction with the decade selection system.

A further amplifier, with a switched feedback network, has a gain of either 'x1' or 'x0.316', and this is used to bring all ranges to the same sensitivity level before feeding the signal into the RMS meter drive unit.

3.3. RMS Meter Drive Unit

The input from the range multiplier unit is fed to a preamplifier and driver combination, which is used to provide the necessary drive for the meter. An output can be taken from the driver stage for use in other equipment, if so required. The signal from the driver stage feeds into a bridge rectifier circuit, and this is followed by a correction network which is used to give the true RMS characteristic and to provide temperature compensation. Additional loading of the correction network by a series of switched capacitors is used to provide a selection of time constants for dealing with random noise signals.

3.4. Power Supply Circuits

A full wave bridge rectifier, followed by a pair of stabiliser modules, gives the +28V and -28V supplies needed for the operation of the instrument. The mains transformer normally fitted is for 200/250V operation, but 115V operation can be provided for if required.

SECTION 4

Technical Description

4.1. Introduction

In addition to the drawing references given in the following paragraphs, reference should also be made to the overall circuit diagram of the equipment (Drg. No. TRV/1/CD). The description of the circuits is based on the path taken by the signal through the system. Where no drawing reference is given in a paragraph, the overall circuit diagram should be used.

4.2. Input Circuits

The input signal is fed from the appropriate input socket to the wiper of section 'D' of the range selector switch. In conjunction with section 'C' of the switch, this provides additional attenuation on the four highest ranges by means of R7 and R8, the capacitors across R8 providing frequency compensation. The signal then passes into the range multiplier unit via R3, which, with R4, forms part of the overvoltage protection circuit.

4.3. Range Multiplier Unit - Preamplifier Stage (Drg. No. SRVC/1/2/CD)

The signal is fed via C1 to the gate of the field effect transistor, VT1, which, in conjunction with VT2, forms a high-input-impedance preamplifier stage. VT1 and

VT2 are both low noise devices and operate at unity gain. Protection against overvoltage conditions is given by D2 and D3, in conjunction with the resistors referred to in the previous paragraph. RV1 is used to bias VT1 to give linear clipping on large amplitude signals. The output is taken from the collector of VT2 via C4.

4.4. Range Multiplier Unit - 'x10' Amplifier Stages (Drg. No. SRVC/1/2/CD)

The preamplifier stage is followed by two identical amplifier stages, each with a gain of ten. Each stage consists of a pair of complementary transistors, the gain of the combination being set accurately to ten by adjustment of a preset potentiometer in the feedback loop between the two transistors. These two stages are used in conjunction with section 'B' of the range selector switch to give decade selection, the input to the next stage being taken from either of the two stages or direct from the preamplifier according to the sensitivity required. Note that on the four highest ranges additional attenuation is provided in the input circuits in order to simplify the range multiplier circuitry.

4.5. Range Multiplier Unit - Switched Gain Amplifier (Drg. No. SRVC/1/2/CD)

Once the appropriate decade has been selected it only remains to distinguish between the '1' and '3.16' ranges. This is accomplished by feeding the signal from section 'B' of the range selector switch to an amplifier stage which can have a gain of either 'x1' or 'x0.316'. An

output signal of 100mV is produced by this stage at full scale deflection of the meter. The amplifier itself is fairly conventional, consisting of a difference amplifier followed by a common emitter stage, and the overall gain is determined by negative feedback through R33. In the 'x0.316' condition, an additional resistor, R37, is switched in parallel with R33 to reduce the gain. This is done by section 'A' of the range selector switch. Additional DC feedback across the amplifier is provided by R27 and R32.

4.6. RMS Meter Drive Unit - Amplifier Stages (Drg. No. TF13A/CD)

The output from the range multiplier unit is fed to the RMS meter drive unit, where it is amplified up to the level required by the meter circuits. A preamplifier stage is followed by a complementary push-pull output stage, which gives an output of 4.5V for an input of 100mV to the preamplifier. The preamplifier stage, VT1, has feedback from the output stage applied to its emitter circuit via the preset potentiometer RV1, which is used to set the overall gain of the amplifier stages. The output from VT1 is fed to a driver stage and then to the complementary push-pull output stage, which uses a conventional transformerless circuit. Feedback to RV1 is via R9, and the output is taken via C5. Short-circuit protection for the output stage is provided by R11, R12, R23, and R24. The output via C5 is fed to the bridge rectifier circuit, and also to a socket which can be connected to other equipments as required, so that the instrument also acts as a calibrated amplifier.

4.7. RMS Meter Drive Unit - Bridge Rectifier and True RMS Network (Drg. No. TF13A/CD)

The bridge rectifier circuit uses diode-connected germanium transistors, since these give a better performance than conventional rectifier diodes. A loading and temperature compensating network follows the bridge rectifier circuit, and this is used to give the required true RMS characteristic. The three diodes, D3, D4, and D5, switch in loading resistors at various voltage levels, working in conjunction with the thermistor, TH1, the temperature compensating element, while R20 is used to set the level for meter full scale deflection. Additional capacitors are connected into the network by the "Time Constant" switch to provide a selection of averaging times when performing measurements on random noise signals. The meter is connected across the network, with an additional series resistor, R21, in the meter positive line. It should be noted that the time constant, as indicated on the selector switch, is the CR time, and thus the meter takes approximately five times this period to settle down.

4.8. Power Supply Circuits - Unstabilised Supplies

The AC mains input is fed via the fuse, FS1, and the on/off switch to the primary of the mains transformer, T1. The centre-tapped secondary feeds a parallel pair of full wave rectifiers which are used to provide the positive and negative unstabilised supplies for the stabiliser circuits. Note that although a bridge rectifier module is used for convenience, the circuit is not that of a bridge rectifier. RC smoothing networks are used on the two supplies, which then feed the positive and negative stabiliser circuits. A neon

indicator is fitted across one section of the mains transformer primary as a power-on indicator. Although the transformer is suitable for use on 100-125V AC as well as the normal 200/250V supplies, it is supplied connected for 200/250V only, and other connections will only be supplied on request. The stabiliser circuits enable the instrument to operate over the specified AC mains voltage range without the use of transformer tappings.

4.9. Power Supply Circuits - Positive and Negative Stabilisiers (Drg. Nos. ARN24A/21P/CD and ARN24A/21N/CD)

These both use the same basic type of circuit, with an error amplifier feeding a driver stage which controls a series regulator transistor. The main differences are in the types of transistor used for the error amplifier and driver stages, caused by the opposite polarities of the two supplies.

In the positive stabiliser circuit NPN transistors are used for the lower level circuits, with VT1 and VT2 forming the error amplifier stage, and VT3 the driver stage. The negative stabiliser circuit uses PNP transistors in the low level stages, and has minor differences in the driver and regulator stages, mainly caused by the use of the same type of transistor for both regulator stages.

4.10. External Connections

For operational convenience, both input and output connections are duplicated, sockets being available at both the front and the rear of the instrument. The mains supply is routed via a three-pin socket at the rear of the instrument.

SECTION 5

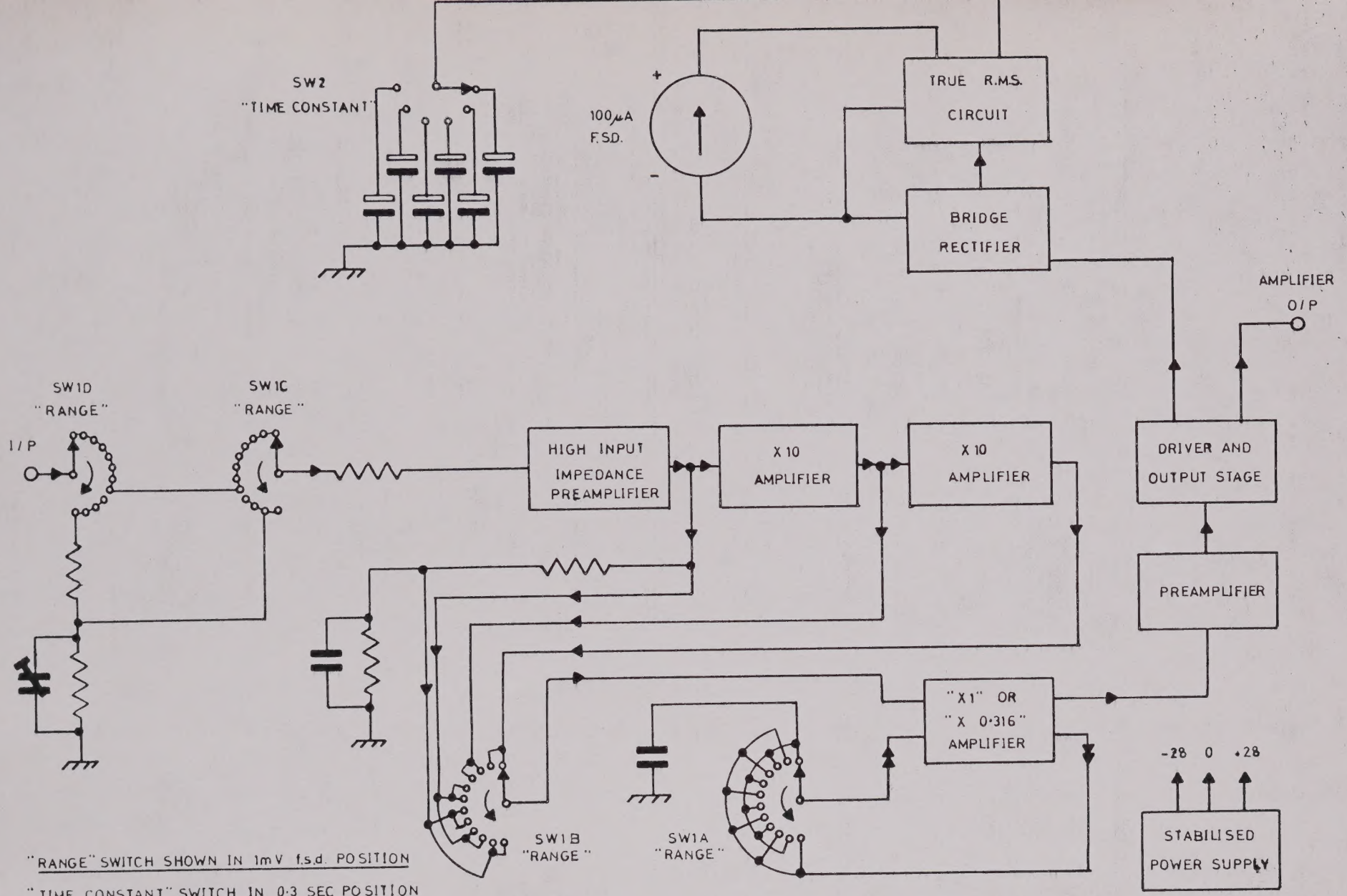
Operation and Maintenance

5.1. Operation

The instrument is supplied fully aligned and tested, and is therefore ready for immediate use. Because of its all solid-state circuitry, no warm-up time is necessary, and the voltmeter can therefore be used almost immediately after switching on. No special precautions are required during use, other than the standard precautions to be observed when measuring a voltage of unknown value:- i.e., to start on a high voltage range and increase the sensitivity until a reading is obtained. The time constant to be used will depend on the nature of the signal being investigated, the longer time constants normally being used on random noise signals. Duplicate input and output sockets are provided on the front and rear panels of the instrument. The g^2/Hz scale on the meter is not used in this instrument and should be ignored during operation. A dB scale is provided on the range switch, with OdB = 1V r.m.s.

5.2. Maintenance

Since the instrument is fully enclosed, little routine maintenance is required, apart from an occasional wipe-down of the front panel with a mild cleansing solution to remove any marks. Should any fault develop, other than a random fuse failure, the Company's engineers should be consulted.



TRUE R.M.S. VOLTMETER TYPE TRV1

BLOCK SCHEMATIC DIAGRAM

Derritron World Wide

The original Derritron philosophy towards vibration testing equipment in 1960 was to provide a single source of supply for vibrators and amplifiers and the associated instrumentation. Previously, these had only been obtainable from different manufacturers. The environmental engineer had to make up his own vibration system and the technical responsibility of interface was usually his.

At that time the only complete systems available were from America. The then thriving British and European Aircraft industries needed their own source of supply.

By integrating two companies, eventually under the name of Derritron Electronics Limited, and developing new lines of equipment a single source of supply was achieved.

Over the subsequent years Derritron Electronics Limited has built up a world-wide reputation—with sales to 41 countries, and over 60% of production being exported annually. It is the only company in the world which designs and manufactures a range of complete electromagnetic systems including:

- Vibrators and slip tables
- Amplifiers
- Instrumentation required for
  (a) Swept Sine
  (b) Broad band random, or
  (c) Digital controlled vibration testing
- Ancillaries such as water-towers, isolation trunnions, etc.

As both design and manufacture are carried out at Hastings, England, all the interface problems are solved prior to delivery. Furthermore, the customer has the benefit of having to contact only one manufacturer.

Since its inception Derritron can claim to have led the way with:

(a) The solution of VIBRATOR SUSPENSION reliability with the introduction of Link-arm suspension.

(b) The commercial availability of an extensive range of "ALL SOLID STATE" POWER AMPLIFIERS specifically designed for operating with vibrators.

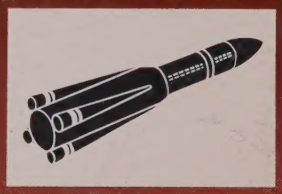
(c) A SWEPT SINE VIBRATION CONTROL CENTRE designed and made by a vibrator manufacturer.

(d) An "ALL SOLID STATE" AUTOMATIC RANDOM NOISE EQUALISER/ANALYSER — for which, incidentally, the "Queen's Award" was granted.

(e) A commercially available DIGITALLY CONTROLLED VIBRATION CENTRE designed and manufactured by a vibrator manufacturer. From the strict and well-defined aerospace requirements, vibration testing has gradually extended into other industries where reliability is increasingly necessary, though for commercial reasons rather than for reasons of safety and the risk of loss of an expensive device. This not only includes most of the electronic and instrument companies but also most of the car manufacturers in Europe. For railways, atomic power, rubber manufacturers, heavy industry, and even the manufacture of rackets and golf clubs, vibration testing is being found a useful means of achieving reliability and excellence at minimum cost.

It is by close liaison with the experienced user that Derritron Electronics Limited has been able to produce equipment which is the most acceptable to the discerning vibration test engineer. Most of the more eminent environmental test engineers in Europe have, at some stage, visited the factory at Hastings.

The basic concept of co-ordinating under one roof the three technical disciplines required to develop and manufacture complete vibration systems has been fully justified, and Derritron Electronics Limited is one of the very few successful companies offering such equipment. Its commercial success and world-wide reputation has resulted in substantial expansion.



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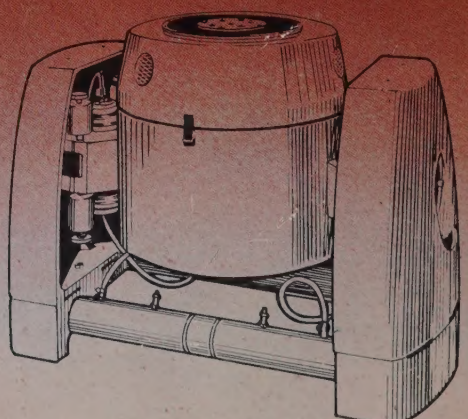

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